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Geophysical Research Abstracts
Vol. 20, EGU2018-15473, 2018
EGU General Assembly 2018

In-situ measurements from citizen observatories for downscaling satellite-derived soil moisture

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Soil moisture has recently been endorsed as an Essential Climate Variable by the Global Climate Observing System, underlining its importance in the global climate system. While in-situ measurements can very well represent the temporal variability of soil moisture, satellite acquisitions allow an excellent representation of spatial patterns. In this way, the two measurement approaches often show complementary phenomena.
The Sentinel-1 (S-1) is a new mission from the European Space Agency, which provides C-band SAR data globally. The backscatter retrieved by Sentinel-1 can be used for estimating surface soil moisture (SSM): the retrieval algorithm provides SSM in degree of saturation, thus ranging from 0% (dry) to 100% (wet), at 1 km spatial resolution. However, for some purposes a deeper knowledge of SSM variability within the pixel is desirable. In such cases, downscaling of remotely sensed observations can help to interpret the useful information contained within the data.
Very few attempts have been done in downscaling remotely sensed soil moisture using in-situ measurements. This is mainly due to the fact that ground observations are costly, and therefore the availability of densely distributed measures is a problem. A new project, the GROW Observatory (https://growobservatory.org), has the potential to fill this gap. Indeed, GROW is going to furnish citizens and farmers with thousands ($\sim$ 10000) of SSM low-cost sensors, yielding an unprecedented stream of data, in terms of quantity and density.
We present a framework for the fusion of satellite and in-situ observations, in order to improve the accuracy of S-1 SSM up to field scale. Preliminary results for a small agricultural catchment in Lower Austria are presented. The approach here introduced allows to investigate the intra-pixel variability of S-1 SSM imagery and to improve SSM estimates up to field-level, thanks to high-density ground measurements. The possibility to estimate SSM at finer spatial scales is pivotal for further studies, such as biomass estimation, irrigation advisory services, etc. More generally, the availability of dense in-situ observations, as offered by citizen observatories, opens new frontiers to the remote sensing community.